

# Community-wide space weather Scoreboards:

## Research assessment of real-time forecasting models and techniques

<http://ccmc.gsfc.nasa.gov/challenges>



Australian Government  
Bureau of Meteorology



UNIVERSITY of  
BRADFORD



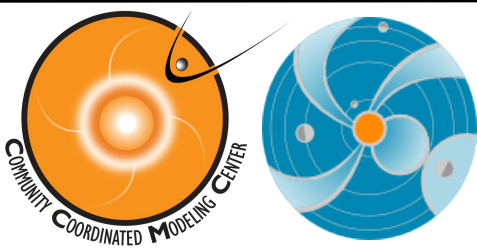
Korea Meteorological  
Administration



KYUNG HEE  
UNIVERSITY



SPACE ENVIRONMENT TECHNOLOGIES  
Space Research Space Operations Space Standards



Royal Observatory  
of Belgium

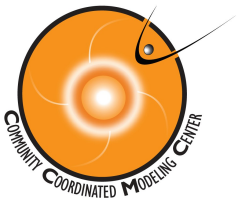


TRINITY  
COLLEGE  
DUBLIN

# Introduction to community scoreboards



- Fostering world-wide community validation projects that ultimately help researchers improve their CME, flare, and SEP forecasts and determine their usefulness.
- Allow a consistent **real-time** comparison of various operational and research forecasts. Complementary to non-real time model assessments such as **CCMC Challenges**.
- The flare and SEP system is automated such that model developers can routinely upload their predictions.
- Forecast data is parsed and stored in a database accessible to anyone via an API.

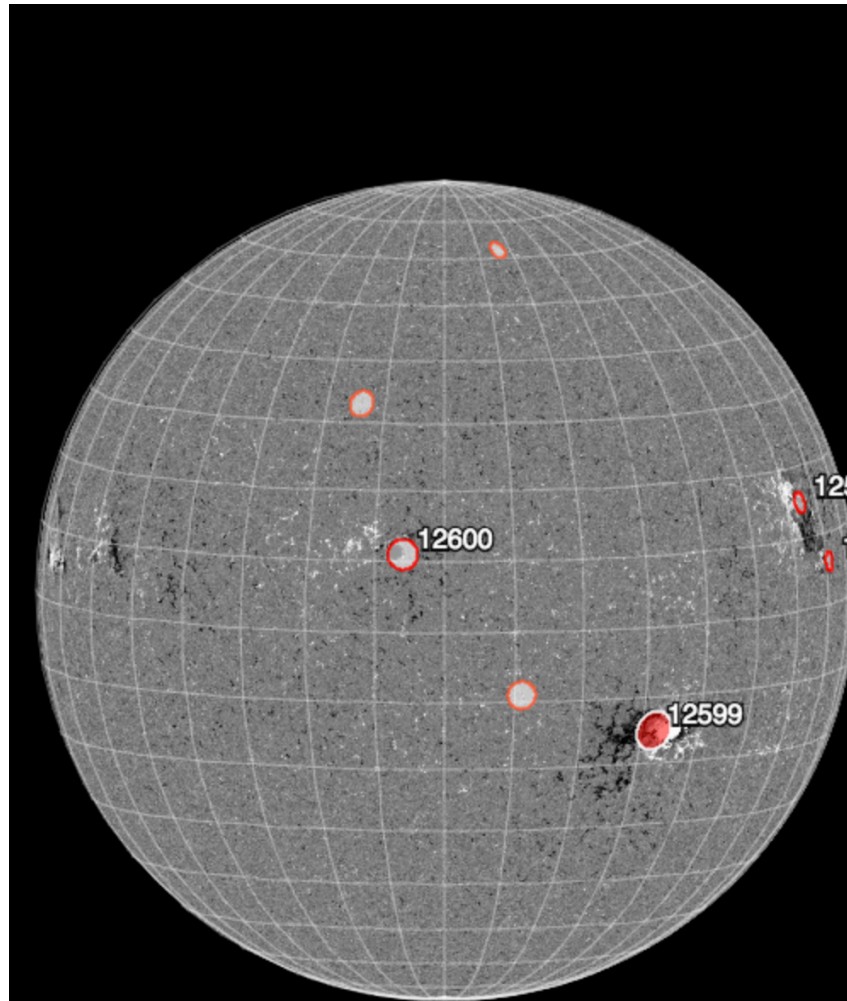


# Flare Scoreboard



<https://ccmc.gsfc.nasa.gov/challenges/flare.php>

- Allows a consistent real-time comparison of various operational and research flare forecasts.
- Automated system; model developers can routinely upload their predictions to an anonymous ftp
- Forecast data is parsed and stored in a database which accessible to anyone via an API
- This project is led by Sophie Murray (TCD) and the planning group includes expert scientists as well as operational space weather prediction centers.



CCMC, Version: 2016-10-12 00:00:00.0

- NOAA Active Regions
- Other Active Regions

## S15W32 Region Flare Predictions (24 hour)

BoM_flare1		M+: 1%	X : 1%
AMOS_v1	C+: 27%	M+: 5%	X : 0%
NOAA_1	C : 20%	M : 1%	X : 1%

Averages	C : 20%	M : 1%	
	C+: 27%	M+: 3%	X : 1%

## Region Location Details

### BoM\_flare1

NOAA AR#: 12599 (S15W32), R: 1.88, Beta

### AMOS\_v1

NOAA AR#: 12599 (S15W32), R: 1.88, Beta

AMOS\_v1 AR#: 1 (S15W32, 2016-10-12 00:00:00.0)

### NOAA\_1

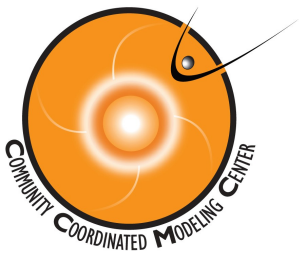
NOAA AR#: 12599 (S15W32), R: 1.88, Beta

## Full Disk Predictions (24 hour)

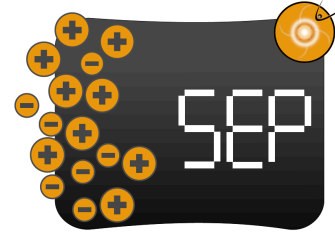
BoM_flare1		M+: 1%	X : 1%
ASSA_24H_1	C : 84%	M : 31%	X : 6%
AMOS_v1	C+: 36%	M+: 6%	X : 0%
NOAA_1		M : 1%	X : 1%
UFCORIN_1	C+: 0%	M+: 0%	X : 0%
MO_TOT1		M : 5%	X : 1%

Averages	C : 84%	M : 12%	
	C+: 18%	M+: 2%	X : 1%





# SEP Scoreboard



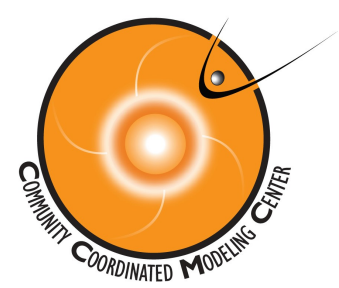
<http://ccmc.gsfc.nasa.gov/challenges/sep.php>

- Planning for the SEP Scoreboard has started (led by BIRA-IASB and the UK Met Office)
- Builds upon the flare scoreboard and CME arrival time scoreboard
- Automated system; model developers can routinely upload their predictions to an anonymous ftp. Forecast data will be parsed and stored in a database which accessible to anyone via an API
- SEP forecasts can be roughly divided into three categories:



- The SEP scoreboard will focus on real-time forecasts (first and second categories) and will collect: proton flux profile, threshold crossing probability, onset time, and duration.
- The SEP scoreboard team will also coordinate a set of historical events for a **SEP Challenge** with different models, particularly those physics-based models in the third category that are not ready or relevant for real-time modeling.



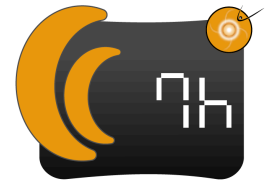


# CME Arrival Time Scoreboard



The CME scoreboard is a research-based forecasting methods validation activity which provides a central location for the community to:

- submit their forecast in real-time
- quickly view all forecasts at once in real-time
- compare forecasting methods when the event has arrived
- view the average of all forecasts for each event (ensemble).

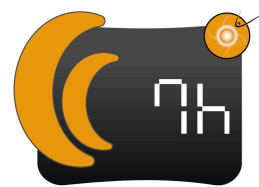


<http://kauai.ccmc.gsfc.nasa.gov/CMEscoreboard>

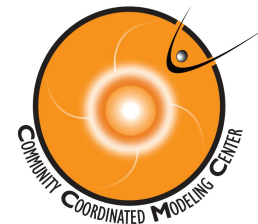
**All prediction methods are welcome and all are encouraged to participate.**

Participation from the community:

- All prediction models and methods are welcome from the world-wide research community (currently 19 methods are registered)
- Users submit their predictions for ongoing CME events, listing their method assumptions and input parameters
- Researchers can then view all of the predictions, modeling details, and the ensemble average of all predicted arrival times submitted by participants



# Community predictions for the 5 Nov 2016 CME



## CME: 2016-11-05T04:48:00-CME-001

Actual Shock Arrival Time: 2016-11-09T05:28Z

Observed Geomagnetic Storm Parameters:

----

CME Note: Filament Eruption off the northern Hemisphere giving a very wide-angle partial halo. Another CME came off the farside and eastern limb at a similar time. Evident in SOHO and STEREO imagery after 05/0200UTC.

Predicted Shock Arrival Time	Difference (hrs)	Confidence (%)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method	Submitted By	
2016-11-08T19:00Z (-12.0h, +12.0h)	-10.47	75.0	2016-11-06T11:10Z	66.30	Max Kp Range: 4.0 - 6.0	<a href="#">Other (SIDC)</a>	Leila Mays (GSFC)	<a href="#">Detail</a>
2016-11-08T16:00Z (-7.0h, +7.0h)	-13.47	----	2016-11-05T17:52Z	83.60	----	<a href="#">WSA-ENLIL + Cone (GSFC SWRC)</a>	Karin Muglach (GSFC)	<a href="#">Detail</a>
2016-11-08T11:15Z	-18.22	57.5	---	---	Max Kp Range: 3.5 - 5.33333	Average of all Methods	Auto Generated (CCMC)	<a href="#">Detail</a>
2016-11-08T10:00Z	-19.47	----	2016-11-06T00:30Z	76.97	Max Kp Range: -- - 5.0	<a href="#">WSA-ENLIL + Cone (NOAA/SWPC)</a>	Barbara Thompson (GSFC)	<a href="#">Detail</a>
2016-11-08T00:00Z (-9.0h, +6.0h)	-29.47	40.0	2016-11-06T01:00Z	76.47	Max Kp Range: 3.0 - 5.0	<a href="#">WSA-ENLIL + Cone (Met Office)</a>	Met Office (Met Office)	<a href="#">Detail</a>

## CME: 2016-11-05T04:48:00-CME-001

Actual Shock Arrival Time: 2016-11-09T05:28Z

Observed Geomagnetic Storm Parameters:

----

CME Note: Filament Eruption off the northern Hemisphere giving a very wide-angle partial halo. Another CME came off the farside and eastern limb at a similar time. Evident in SOHO and STEREO imagery after 05/0200UTC.

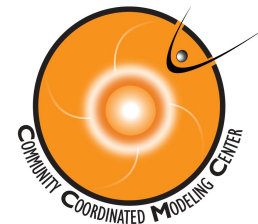
Predicted Shock Arrival Time	Difference (hrs)	Confidence (%)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method
2016-11-08T19:00Z (-12.0h, +12.0h)	-10.47	75.0	2016-11-06T11:10Z	66.30	Max Kp Range: 4.0 - 6.0	<a href="#">Other (SIDC)</a>
2016-11-08T16:00Z (-7.0h, +7.0h)	-13.47	----	2016-11-05T17:52Z	83.60	----	<a href="#">WSA-ENLIL + Cone (GSFC SWRC)</a>
2016-11-08T11:15Z	-18.22	57.5	---	---	Max Kp Range: 3.5 - 5.33333	Average of all Methods
2016-11-08T10:00Z	-19.47	----	2016-11-06T00:30Z	76.97	Max Kp Range: -- - 5.0	<a href="#">WSA-ENLIL + Cone (NOAA/SWPC)</a>
2016-11-08T00:00Z (-9.0h, +6.0h)	-29.47	40.0	2016-11-06T01:00Z	76.47	Max Kp Range: 3.0 - 5.0	<a href="#">WSA-ENLIL + Cone (Met Office)</a>

<http://kauai.ccmc.gsfc.nasa.gov/CMEscoreboard>

Please join! All prediction methods are welcome and all are encouraged to participate.



# Community predictions for the January 7, 2014 CME (X1.2 flare):



15 submissions

Average of all submissions: **12 hours early, Kp geomagnetic index 6 to 7.6**

CME: 2014-01-07T18:24:00-CME-001

Actual Shock Arrival Time: 2014-01-09T19:32Z

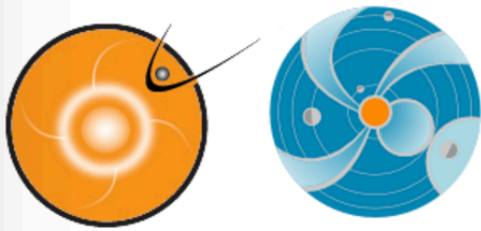
Observed Geomagnetic Storm Parameters:

Max Kp: 3.0

<http://kauai.ccmc.gsfc.nasa.gov/CMEScoreboard>

Predicted Shock Arrival Time	Difference (hrs)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method
2014-01-10T04:04Z (-16.0h, +36.0h)	8.53	2014-01-08T14:56Z	28.60	Max Kp Range: 8.0 - 8.0 Dst min. in nT: -300	<a href="#">COMESSEP</a>
2014-01-09T19:26Z (-10.0h, +10.0h)	-0.10	2014-01-07T21:00Z	46.53	----	STOA
2014-01-09T13:00Z (-7.0h, +7.0h)	-6.53	2014-01-08T23:17Z	20.25	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone
2014-01-09T12:00Z (-7.0h, +7.0h)	-7.53	2014-01-08T06:32Z	37.00	----	WSA-ENLIL + Cone
2014-01-09T11:22Z (-11.7h, +9.1h)	-8.17	2014-01-09T18:57Z	0.58	Max Kp Range: 3.0 - 5.0	Ensemble WSA-ENLIL + Cone (GSFC SWRC)
2014-01-09T08:02Z	-11.50	2014-01-08T16:37Z	26.92	----	Expansion Speed Prediction Model
2014-01-09T08:00Z	-11.53	2014-01-08T01:31Z	42.02	Max Kp Range: 6.0 - 7.0	<a href="#">WSA-ENLIL + Cone (NOAA/SWPC)</a>
2014-01-09T06:35Z	-12.95	---	---	Max Kp Range: 6.0 - 7.625	Average of all Methods
2014-01-09T04:30Z (-2.5h, +2.5h)	-15.03	2014-01-08T05:02Z	38.50	Max Kp Range: 5.0 - 8.0	<a href="#">Other (SIDC)</a>
2014-01-09T04:00Z (-6.0h, +6.0h)	-15.53	2014-01-08T09:42Z	33.83	----	<a href="#">DBM</a>
2014-01-09T02:00Z	-17.53	2014-01-08T17:53Z	25.65	Max Kp Range: 8.0 - 9.0	<a href="#">BHV</a>
2014-01-09T01:00Z	-18.53	2014-01-08T23:00Z	20.53	Dst min. in nT: -142 Dst min. time: 2014-01-09T12:00Z	<a href="#">Anemomilos</a>
2014-01-09T00:38Z (-7.0h, +7.0h)	-18.90	2014-01-08T00:41Z	42.85	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone (GSFC SWRC)
2014-01-09T00:17Z (-6.9h, +9.2h)	-19.25	2014-01-08T04:11Z	39.35	Max Kp Range: 6.0 - 8.0	Ensemble WSA-ENLIL + Cone (GSFC SWRC)
2014-01-08T22:00Z	-21.53	2014-01-08T03:17Z	40.25	Dst min. in nT: -146 Dst min. time: 2014-01-09T11:00Z	<a href="#">Anemomilos</a>
2014-01-08T12:30Z	-31.03	2014-01-08T05:58Z	37.57	----	ESA

**Please join! All prediction methods are welcome and all are encouraged to participate.** There are currently 19 registered models.



## CME ScoreBoard



[Login](#)

### CME Scoreboard

*CME arrival time predictions from the research community:*

The CME Scoreboard (developed at the Community Coordinated Modeling Center, [CCMC](#)) is a research-based forecasting methods validation activity which provides a central location for the community to:

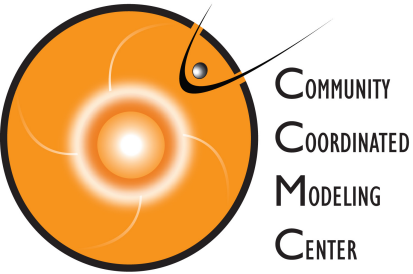
- submit their forecast in real-time
- quickly view all forecasts at once in real-time
- compare forecasting methods when the event has arrived

Using this system:

- Anyone can view prediction tables
- Users can enter in your CME shock arrival time forecast after logging in:
  - Registered Users: Begin by finding your CME under the "Active CMEs" section, then click "Add Prediction" and select your forecasting "Method Type" from the list. (Click [here](#) to register for an account.)
  - Power Users: If you do not see your CME listed under the "Active CMEs" section, click "[Add CME](#)" to get started (Click [here](#) to request power user privileges). To enter the actual CME shock arrival time, click "*Edit CME*" after you are done entering your prediction(s).
- [Click here to see a list of registered methods](#). If you would like to register your prediction method, please send an email to [M. Leila Mays](#) or [Yihua Zheng](#) with your model/technique details.
- [Click here for more detailed instructions](#).

<http://kauai.ccmc.gsfc.nasa.gov/CMEScoreboard>

Anyone can view predictions, please register to submit predictions.



Begin by clicking **Add Prediction** under the "Active CMEs" section and select your forecasting "Method Type" from the list. While logged in, if you do not see any CMEs listed under the "Active CMEs" section, click **Add CME** to get started.

Using this system:

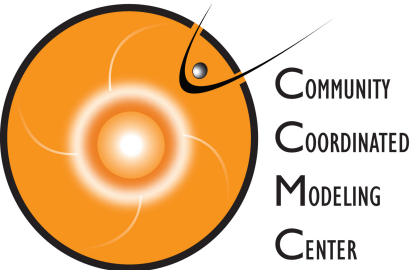
- Anyone can view prediction tables
- Users can enter in your CME shock arrival time forecast after logging in:
  - Registered Users: Begin by finding your CME under the "Active CMEs" section, then click "Add Prediction" and select your forecasting "Method Type" from the list. (Click [here](#) to register for an account.)
  - Power Users: If you do not see your CME listed under the "Active CMEs" section, click **"Add CME"** to get started (Click [here](#) to request power user privileges). To enter the actual CME shock arrival time, click "*Edit CME*" after you are done entering your prediction(s).
- [Click here to see a list of registered methods](#). If you would like to register your prediction method, please send an email to [M. Leila Mays](#) or [Yihua Zheng](#) with your model/technique details.

## Active CMEs:

**Note:** If you can't find your CME below, please click **"Add CME"** to add your CME. To enter the actual CME shock arrival time, click "*Edit CME*" after you are done entering your prediction(s).

CME: 2015-01-01T00:00:00-CME-001
<a href="#">Edit CME</a>
<a href="#">Delete CME</a>
<b><a href="#">Add Prediction</a></b>
No Prediction Entered for this CME yet!

<http://kauai.ccmc.gsfc.nasa.gov/CMEScoreboard>



COMMUNITY  
COORDINATED  
MODELING  
CENTER

<http://kaudi.ccmc.gsfc.nasa.gov/CMEScoreboard>

## Prediction Form for CME (2014-01-01T00:00:00-CME-001)

Enter submission time in format (yyyy-MM-dd'T'HH:mm'Z' i.e. 2012-07-12T16:52Z) :

Method Type ([details](#)):

Prediction notes: (Please include all initial conditions/parameters used in your prediction)

✓ --- Select ---  
Anemomilos  
Ballistic projection  
BHV  
DBM  
ECA  
ESA  
H3DMHD (HAFv.3+3DMHD)  
HAFv.3  
HAFv2w  
HI J-map  
Other  
Other (ips.gov.au)  
Other (SIDC)  
STOA  
TH  
WSA-Enlil + Cone  
WSA-Enlil + Cone (GSFC SWRC)  
WSA-Enlil + Cone (NOAA/SWPC)

Enter predicted CME shock arrival time in format (yyyy-MM-dd'T'HH:mm'Z' i.e. 2012-07-12T16:52Z) :

Positive Error Bar in hours (optional):

Negative Error Bar in hours (optional):

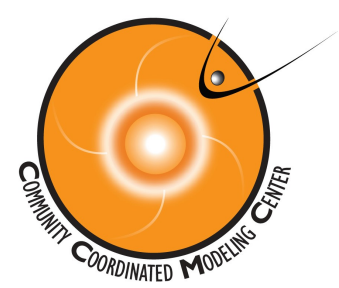
Kp Range Lower Limit (optional):

Kp Range Upper Limit (optional):

Dst min. in nT (optional):

Dst min. time in format (yyyy-MM-dd'T'HH:mm'Z' i.e. 2012-07-12T16:52Z) (optional):





# CME Arrival Time Scoreboard



## **Suggested improvements coming soon:**

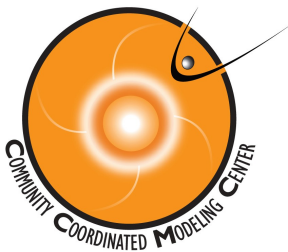
- Automatic forecast submission via an XML file
- Mailing list that notifies users when a new CME has been added to the scoreboard
- Separate geomagnetic storm scoreboard that can link to CME scoreboard

## **Future plans:**

- Showing data in table in plot form
- Automatic skill score calculations
- Quality factor for confidence in observed ICME associated shock arrival
- Quality factor for confidence in linking observed ICME arrival with CME in coronagraph
- Your ideas?

<http://kauai.ccmc.gsfc.nasa.gov/CMEscoreboard>

Display mock-ups



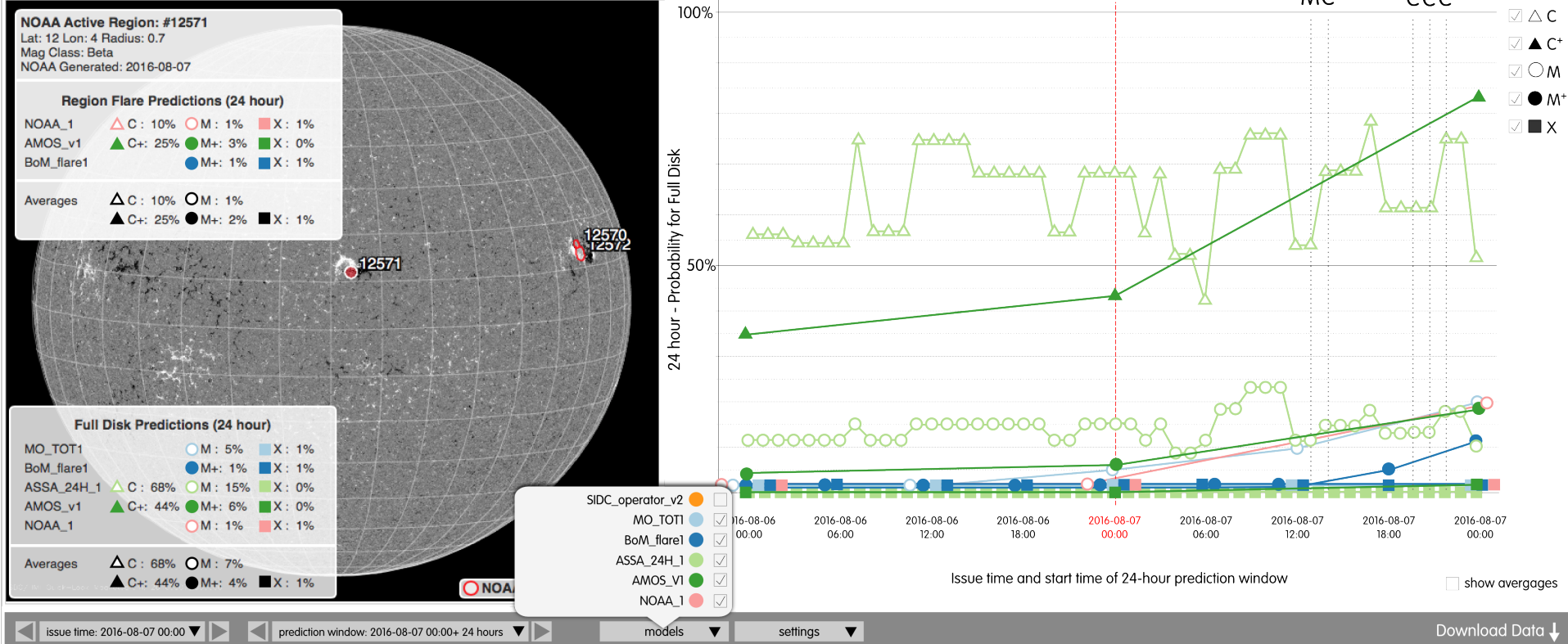
# Flare Scoreboard



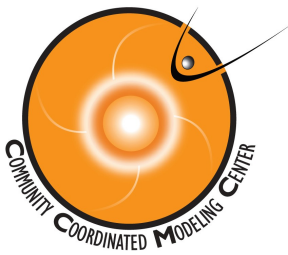
<http://ccmc.gsfc.nasa.gov/challenges/flare.php>

## Solar Flare Scoreboard

Snapshot for prediction window: 2016-08-07 00:00 - 2016-08-07 00:00 from issue time: 2016-08-07 00:00

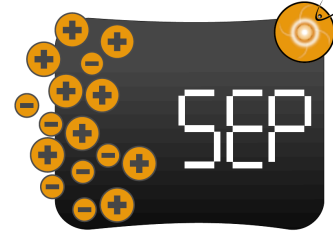


The full disk and active region flare forecasts can currently be viewed on an interactive display overlaid on an SDO/AIA or HMI image of the Sun and will be dynamically paired with a graph of flare probability vs. time (coming soon)

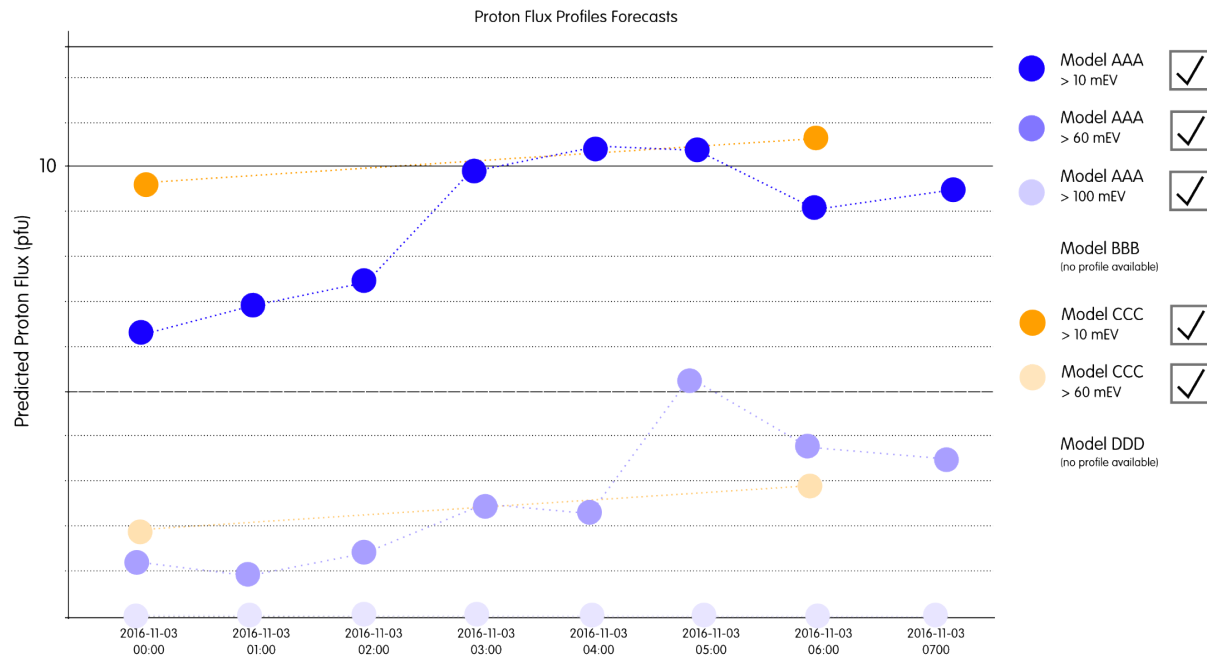
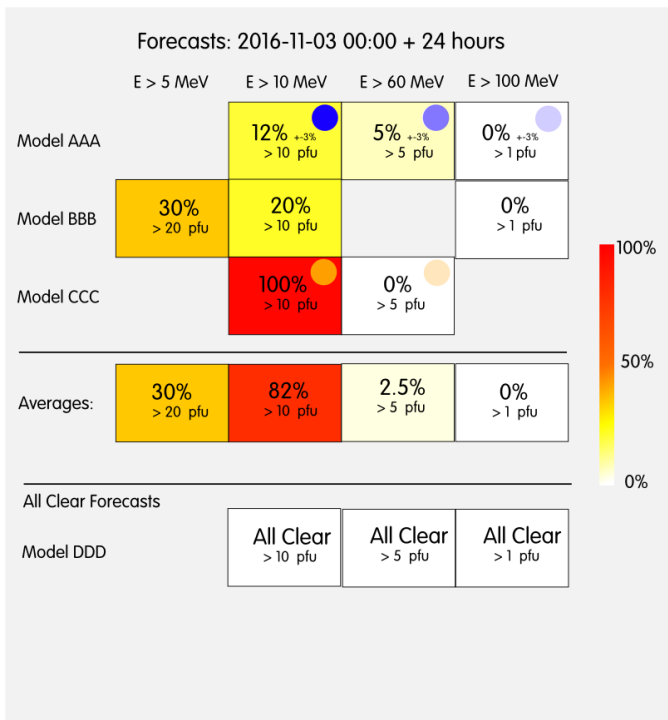


# SEP Scoreboard

## Display ideas



SEP Scoreboard



issue time: 2016-11-03 00:00

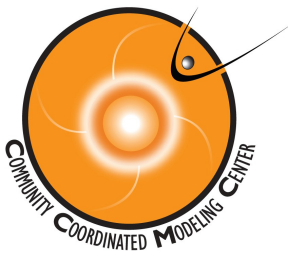
settings

models

Download Data

*Probability heat map at a single time*

*Predicted proton flux time-series*

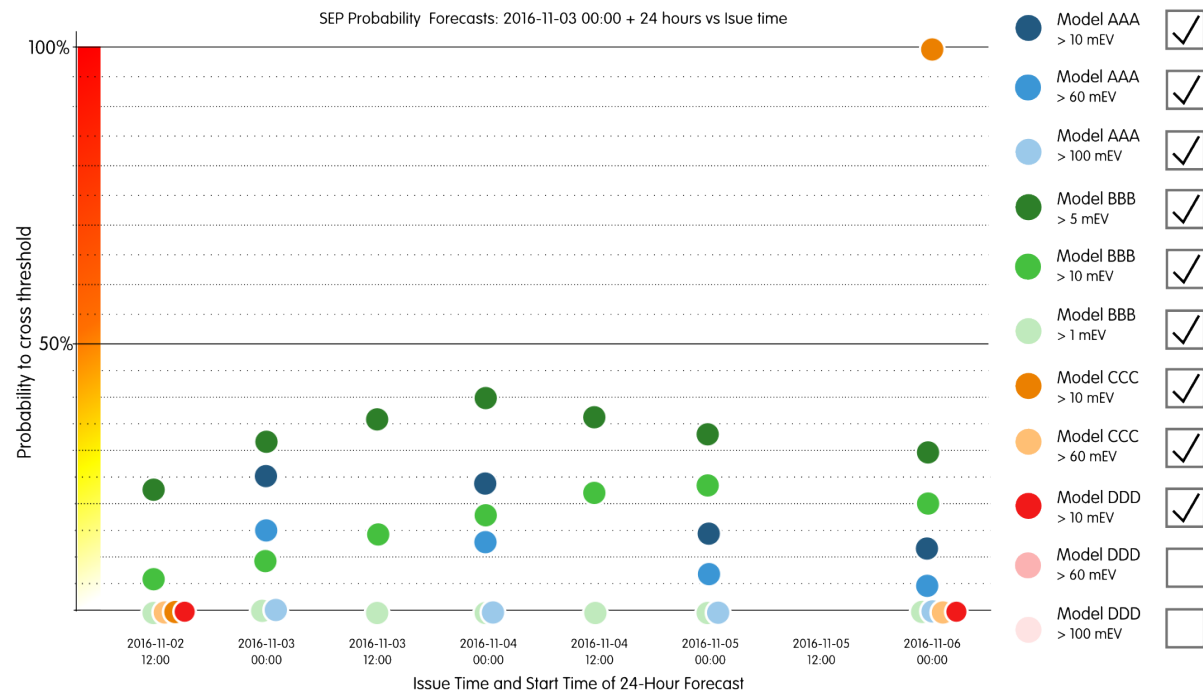
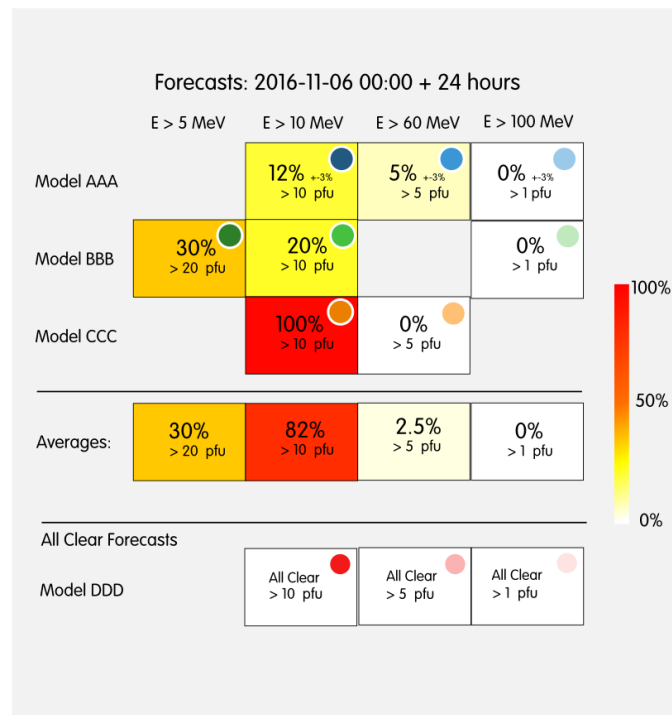


# SEP Scoreboard

## Display ideas



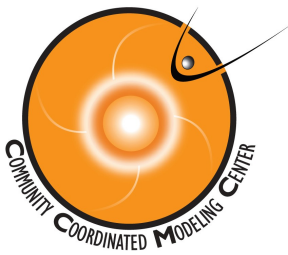
SEP Scoreboard



*Probability heat map at a single time*

*Probability time-series*

Download Data



# Linking the Scoreboards



Example of activities linked to a CME event in the CCMC DONKI database:

<http://kauai.ccmc.gsfc.nasa.gov/DONKI>

## Coronal Mass Ejection

Catalog: SWRC\_CATALOG

Start Time: 2015-03-15T02:00Z ( SOHO: LASCO/C2 )

All Detecting Spacecrafts:

SOHO: LASCO/C2

SOHO: LASCO/C3

Activity ID: 2015-03-15T02:00:00-CME-001 (version 4)

Source Location: S15W24

Active Region Number: 12297

Note: This CME is connected to the long duration C9.1 flare erupting, bright post-flare arcade later in AR 2297

*Submitted on 2015-03-15T14:17Z by Karin Muglach*

[2015-03-15T01:15:00-FLR-001](#)

FLR Type: C9.1

[2015-03-16T07:36:00-SEP-001](#)

SOHO: COSTEP 15.8-39.8 MeV

[2015-03-17T04:05:00-IPS-001](#)

Location: Earth

[2015-03-17T06:00:00-GST-001](#)

NOAA Kp: 6 (2015-03-17T09:00Z)

NOAA Kp: 6 (2015-03-17T12:00Z)

NOAA Kp: 8 (2015-03-17T15:00Z)

NOAA Kp: 8 (2015-03-17T18:00Z)

NOAA Kp: 7 (2015-03-17T21:00Z)

NOAA Kp: 8 (2015-03-18T00:00Z)

NOAA Kp: 6 (2015-03-18T03:00Z)

NOAA Kp: 6 (2015-03-18T18:00Z)

[2015-03-17T06:23:00-MPC-001](#)